Appendix A

Conceptual Transit Planning Guidelines

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This section documents the general guidelines used to estimate the capital and operating costs of the conceptual transit services defined in this project.

A number of parameters impact the capital and operating cost of any type of transit service. These include, but are not limited to, the following:

- The assumed transit operating speed;
- The assumed service frequency or headway;
- The assumed daily, weekly, and annual hours of operation;
- The operating costs of the vehicles;
- The capital cost of the vehicles and supporting facilities such as passenger waiting shelters; and
- The need for vehicle maintenance facilities.

Each of these topics is briefly discussed below. A brief discussion of ridership estimation methodology is presented at the conclusion of this appendix.

Assumed Transit Operating Speed

For any particular transit mode, a route operating at the highest practical speed between its terminus points without stopping is more efficient than one which is required to make stops on a regular basis at a number of intermediate locations. Thus, for example, an express bus operating between a suburban park-and-ride lot and a downtown business district operates more efficiently than if the same vehicle were used on a local bus route with stops every few blocks.

For the general type of alternative transit services considered at any of the NPS, FWS, and BLM sites, it was assumed that only bus or tram type vehicles would be operated. Similarly, it was considered likely that one of two types of routings would be operated:

- An internal site shuttle with multiple stops along internal park roadways; and
- A linkage between either multiple site units or from a Federal lands area to a nearby gateway community using existing public roadways.

In the case of an internal site shuttle, an average operating speed of 15 mph was assumed. In the case of a linkage type operation between multiple site units or from a Federal lands area to a nearby gateway community, an average operating speed of 30 mph was assumed.

It must also be noted that the cycle time (the time required for each vehicle to complete a run and be ready for its next run) includes layover and recovery time. For the purposes of this analysis, an average layover/recovery time of five minutes or 10 percent of the run was used, whichever was greater. Average operating speeds different from these values were used when unique operating conditions made default values unrealistic.

Assumed Service Frequency

The assumed service frequency or headway is one of the most important factors in defining the cost of transit operations. For example, at an assumed operating speed of 15 mph (4 minutes per mile), it would take 60 minutes for a bus to complete a 15-mile long round-trip. Including a 10 percent layover/recovery time factor, the total cycle time would be equal to (60 minutes) X (1.10) = 66 minutes. At an assumed service frequency of once every 60 minutes, a trip of this length would require:

(66 minutes per trip)/(60-minute service frequency) = 1.1 buses (say 2 buses)

At a service frequency of once every 30 minutes, a trip of the same length would require:

(66 minutes per trip)/(30-minute service frequency) = 2.2 buses (say 3 buses)

At a service frequency of once every 15 minutes, a trip of this same length would require:

(66 minutes per trip)/15-minute service frequency) = 4.4 buses (say 5 buses)

For the purposes of this analysis, a range of service frequencies was employed, with a "low" level of service being once every 30 minutes (2 buses per hour), a "medium" level of service being once every 15 minutes (4 buses per hour), and a "high" level of service being 6-8 buses per hour (a bus every 8-10 minutes).

Any "fractional" buses determined through this process (i.e., a 50-minute round trip/a 30-minute service frequency = 1.67 vehicles) were rounded up to the next full integer value (i.e., 2 vehicles).

In addition, a 15 percent spare vehicle ratio was assumed, with a minimum of two spare vehicles in most cases.

Assumed Daily, Weekly, and Annual Hours of Operation

Once the number of vehicles required to operate a particular transit service at a specified headway was defined, it was necessary to translate this into the amount of service being provided, in terms of either vehicle-miles or vehicle-hours, or both. Given the conceptual nature of this analysis, only vehicle-hours of operation were usually estimated.

To the degree possible, vehicle-hours of operation were tailored to the specific and unique needs of each unit. The seasonal needs of each site were determined using visitation statistics if available. Also, varying service levels over the course of the day and by day of week (i.e., more on Saturday and Sunday than on Monday-Friday) were included for each site as necessary.

While recognizing the special nature of visitation at many of the sites that have been visited, (i.e., widely varying visitation levels throughout the year), the following general planning assumptions were used as "default" values where no better information was available:

- For any park or other Federal lands area where transit service is to be provided, the service was assumed to operate 10 hours per day (i.e., 8:00 a.m. until 6:00 p.m.);
- For any park or other Federal lands area where transit service is to be provided, the service was assumed to operate seven days per week;
- For parks and other Federal lands with heavy summer visitation levels, transit services were assumed to operate only from May 1 through September 30 of any given year (153 days per year, including holidays); and
- For parks and other Federal lands with relatively steady visitation levels throughout the year, transit services were assumed to operate from January 1 through December 31 of any given year (365 days per year, including holidays).

Thus, for example, a transit route which requires the use of two (2) buses to provide the assumed service frequency that is located in a park with heavy summer visitation levels resulted in the following annual hours of operation:

(2 buses/hour) X (10 hours per day) X (153 days per year) = 3,060 annual vehicle-hours

Assumed Operating Cost of Vehicles

Once an estimate was made of the annual vehicle-hours of service to be operated, it was necessary to translate this into an estimated annual operating cost for the service. The operating cost of any particular transit service can vary widely, and is dependent upon such factors as driver salaries, the cost of fuel, maintenance costs, etc.

In the course of previous work for the National Park Service, BRW determined that a cost of $50.00 per vehicle-hour is a good, all-inclusive approximation of typical transit operating costs. While higher and lower operating costs per hour have been observed, the typical mid-point of the range, for a number of different vehicle types and operating conditions, is approximately $50.00 per hour.

For the purposes of this conceptual level analysis, this value of $50.00 per vehicle-hour was generally used. However, for those situations where an existing ATS service was already in operation with documented operating costs per vehicle-hour significantly lower than this "default" value of $50.00 per hour, these documented lower costs were used.

For the example discussed above, a transit service requiring 3,060 annual vehicle-hours of operation would cost approximately:

(3,060 vehicle-hours) X ($50.00 per vehicle-hour) = $153,000 annually.

Capital Costs of the Vehicles

As in the case of transit operating costs, a wide range of costs are observed with respect to the capital acquisition costs of transit vehicles. For example, the 1994 Alternative Transportation Modes Feasibility Study conducted for the National Park Service by BRW identified costs for 10-20 passenger shuttle/van type vehicles in the range of $25,000 to $50,000 per vehicle, depending upon equipment. Similarly, this earlier study identified a cost range of $150,000 to $200,000 for a "standard," full-size (40-foot) urban transit bus capable of carrying 40-50 passengers. More recent work by BRW identified an average capital cost for a "full-size" urban transit bus of approximately $300,000 per vehicle.

For the purpose of this analysis, the following unit costs for "standard" bus type vehicles were used:

Small/Medium Bus	$225,000 each
Full-Size Bus	$300,000 each
Over the Road/Tour Coach	$350,000 each

These costs are for transit type buses. Many sites may be able to use school-bus type buses or shuttle-vans, which are much lower in cost. For example, Denali National Park's entire ATS operation is run with Blue Bird transit-style school buses, which cost on the order of $100,000 each.

For those locations where a "shuttle" or "tram" type service was considered, the following unit costs were used:

Powered Drive Unit	$100,000 each
Unpowered Trailer	$ 65,000 each

Adjustments were made based on cost information developed for the Volume I report.

Vehicle Maintenance Facilities

Where new transit services are being proposed, there may be a requirement for some type of maintenance facility to be provided as well. For the purposes of this project, three options were considered: 1) an appropriate vehicle maintenance facility already exists; 2) no such facility exists and would thus have to constructed in order for the proposed ATS service to be operated; or 3) the number of vehicles was too small (6 or less) to justify construction of a new facility, so it was assumed that services would be provided by an existing operator, with a facility, but that some expansion may be needed.

For the purposes of this conceptual level analysis, the following maintenance facility planning and design guidelines and unit costs were employed.

For small bus fleets such as those likely to be associated with virtually any Federal lands ATS services, the vehicle maintenance bays can be multi-function. The minimum size assumed for such a vehicle maintenance facility was one bus bay with an adjacent shop and parts storage area and a small office. The resulting minimum requirement was a 45' X 55' building. In addition, outdoor vehicle storage space requires 10.5-foot wide lanes with enough length to accommodate the fleet. A unit length of the assumed vehicle length plus 5.0 feet was used to determine the length of the vehicle storage lanes.

The unit costs used at Mount Rainier National Park for a newly recommended vehicle maintenance building and associated equipment were: $130 per square foot for the building, plus $10 per square foot for paved vehicle storage areas.

Space requirements for various vehicle maintenance functions were assumed as follows:

Maintenance Facility Factors	**Example – 10 Bus Fleet**
General Repairs – 1 bay/20 buses	10/20 = 0.50 bay
Inspection – 1 bay/50 buses	10/50 = 0.20 bay
Major Repairs – 1 bay/60 buses	10/60 = 0.17 bay
Brake Repairs – 1 bay/100 buses	10/100 = 0.10 bay
Tire Repair – 1 bay/200 buses	10/200 = 0.05 bay
Body Repair – 1 bay/75 buses	10/75 = 0.13 bay
Brake Shop – 4 square feet/bus	Total = 1.15 bays (say 2 bays)
Tire Shop – 4 square feet/bus	
Common Work Area – 6 square feet/bus	
Equipment Storage – 5 square feet/bus	
Body Shop – 4 square feet/bus	
Parts Storage – 20 square feet/bus	
Total Shop Space – 43 square feet/bus	(43 SF/bus) X (10 buses) = 430 SF

Assuming a 40' long, 10' wide (including mirrors) transit bus, the minimum dimension of each enclosed bus maintenance bay would be as follows:

- Length = 40 feet + 10 feet (front clear area) + 10 feet (rear clear area) = 60 feet;
- Width = 10 feet + 10 feet (side clear area) + 10 feet (side clear area) = 30 feet; and
- Maintenance bay area = (60 feet) X (30 feet) = 1,800 square feet.

In addition, space should be provided in the building for offices, restrooms, and driver shower and break rooms. These auxiliary areas typically require approximately 15 percent of the total estimated shop space. For the example shown above, the auxiliary areas would be approximately (0.15) X (430 SF) = 65 SF. The total building size for this example 10-bus fleet would thus be as follows:

Maintenance Bays	2 bays @ 1,800 sq. ft./bay = 3,600 sq. ft.
Shop Area	430 sq. ft.
Offices, Other	65 sq. ft.
	Total = 4,095 sq. ft. (say 4,100 sq. ft.)

At an average cost of $130 per square foot, this example maintenance facility would cost approximately ($130 per sq. ft.) X (4,100 sq. ft.) = $533,000. An additional 60 percent was then added to building costs to account for site preparation, utilities, construction planning, and construction supervision, thus raising the total cost to $853,000.

Similarly, outside storage for the example 10-bus fleet would require approximately:

(40 foot bus length + 5 foot space between vehicles)
X (10.5 foot wide lanes)
X (10 vehicles) = 4,725 sq. ft. of paved area
+ 10% for vehicle circulation = (0.10) X (4,725 sq. ft.) = 473 sq. ft.

Total = 4,725 + 473 = 5,198 sq. ft. (say 5,200 sq. ft.)

(5,200 sq. ft.) X ($10.00 per sq. ft.) = $52,000

The total cost of this example 10-vehicle maintenance facility, including outside vehicle storage, would be approximately $533,000 + $52,000 = $585,000. An additional 50 to 60 percent was added to the estimated cost of the facility for land cost, utilities and construction management.

■ Other ATS System Related Costs

In addition to vehicles and associated maintenance facilities, the operation of an ATS system may also have additional capital costs. These primarily include the provision of passenger waiting shelters or the creation/expansion of parking areas for visitor vehicles.

In the case of passenger waiting shelters, the use of standard, commercially available shelters was assumed for the purposes of this conceptual level analysis. A typical high-quality, low-maintenance passenger waiting shelter with a capacity of 10-15 people costs approximately $10,000 installed on site.

With regard to parking areas for visitor vehicles, it was assumed that approximately 100 automobile sized parking spaces could be provided for each acre of land provided for this purpose. This assumes that the parking area contains full-size parking stalls, circulation lanes of relatively generous width, and a moderate amount of landscaping. Using these assumptions, every 100 spaces (requiring an area of approximately 43,560 sq. ft.) would cost approximately (43,560 sq. ft.) X ($10 per sq. ft.) = $435,600 (say $436,000).

These values for passenger waiting shelters and visitor parking areas were used as appropriate.

While these values are appropriate for estimating the initial, one-time capital acquisition cost to initiate any newly proposed services, it is acknowledged that even the best maintained transit vehicles will eventually wear out and need to be replaced. The generally accepted life expectancy of a bus type transit vehicle is 12 years. ***Therefore, for any Federal lands transit services that are assumed to be initiated over the next 10 years (i.e., 2001-2010), a replacement of the vehicle fleet will be required during the subsequent 10-year period (i.e., 2011-2020). If a particular transit service is not anticipated to be initiated until 2010 or later, no replacement of the vehicle fleet is assumed.***

Guidance on ATS Ridership Estimation

The estimation of ridership for any public transit service is, at best, an inexact process. However, based on the experience of the consultant team in the conduct of similar transportation studies at a variety of units of the National Park Service over the past several years, the following method was used for the estimation of potential ATS ridership.

1. Determine which of the following three cases best describes the proposed ATS service being proposed:

   – A ***voluntary*** service that is supplemental to private vehicle access to the site.

   – A ***mandatory*** service that is designed to accommodate a portion of the visitors to and from the area. Most commonly, this is the volume of visitors in excess of the capacity of the existing roads and/or parking areas. Alternatively, this may be the visitor demand currently using a facility that the NPS or other FLMA would like to relocate to an ATS system due to resource impacts.

- A ***replacement*** for private vehicle access that would serve all visitors (or perhaps only all day-use visitors).

2. ***For the voluntary/supplemental service***, best judgment was used to estimate potential demand. Unless there is a significant impediment to driving to the site, the demand for this type of service can be expected to be low, perhaps only five to 10 percent of total daily visitors. However, if parking is hard to find and the alternative ATS service offered is good, demand can be substantially higher. For example, in the Yosemite Valley, the NPS shuttle service attracts more than one boarding passenger per daily visitor.

3. ***For the mandatory service***, the capacity of the existing private vehicle access system, which will probably be constrained by the available parking supply was determined. The capacity of the access system to exiting and/or forecast demand was then compared. The percentage of visitors that would need to be served by an ATS system to avoid overflow parking or excessive traffic congestion on the access roadways was then estimated. It was assumed that traffic and visitor management measures would be taken to limit vehicle access to the available capacity and that the excess demand uses the ATS system provided.

4. ***For the replacement for private vehicle access type of services***, the ATS system demand was assumed to be equal to the existing (or forecast) visitation level.

For any particular site, it should be noted that changes in visitor access policies are likely to affect the estimated ridership. The effects of these policies are uncertain and may result in demand that is higher or lower than existing conditions.

There are also some general "rules of thumb" that can be applied to daily demand estimates to arrive at peak-hour demand forecasts. As a "default" value, 12 percent of daily demand was used as an estimation of peak-hour demand. Most parks have a three- to four-hour period in the morning when arrivals equal 10 to 12 percent of daily arrivals and a similar three- to four-hour period in the late afternoon or early evening. Many parks have conditions that cause unusual demand patterns. For example, Old Faithful Geyser eruptions at Yellowstone National Park are followed by high volumes of visitor egress, sunsets at the Grand Canyon are followed by high volumes of egress, and special programs at Carlsbad Caverns cause concentrated demand. To the degree possible by existing data or observations by site personnel, such special conditions were considered in the estimation of potential ATS system demand.